Ecological Design and Sensual Architecture:

Climate Design, Beauty, and the Building Envelope

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“The ecological goal in building design should be to strive for a reduction in the total primary energy needs to a minimum, and ideally down to zero, by using only renewable resources and incidental heat gains to ‘drive’ a building’s comfort system, and with the minimal use of continual importing of energy to maintain comfort. By utilizing the building fabric itself [the ‘skin’], artificial heating, cooling, lighting, and other energy importing systems can be minimized, or avoided altogether. Ideally, a building is a power station in its own right.”

Intelligent Skins

“You’re looking for something, you start to verbalize what it is that you want, and all of a sudden it’s there – this strong initial image, or feeling for an atmosphere, which the place and the task provoke...I like to think of a building as something whole and complete, with no part more or less beautiful or important than the others...The building is exactly what we see and touch, exactly what we feel beneath our feet...The sensuous presence of materials defines the space.”

Peter Zumthor

Introduction to the Building Envelope

Buildings did not initially exist as “power stations” or even as “sensuous spaces”, but rather as safety mechanisms. Structures as early as the primitive hut provided safeguard from danger and protection from the elements. Humans have adapted to extremely diverse climatic and geographic conditions thus producing a wide variety of energy-efficient buildings while simultaneously utilizing a wide variety of ecological and sensual materials. Key building elements, such as the building envelope, play a significant role in determining both the building’s image and its energy use.

The building envelope is the interface between the interior of the building and the exterior environment. The technical components of the building...
The building envelope includes the walls, roof, and foundation; however, this paper will focus primarily on the building ‘skin’, generally the façade, as it relates to climate design (the ecological) and aesthetics (the sensual). Due to its immediate exposure to exterior climate conditions and overarching aesthetic presence, the building envelope is the most significant component of climate response and sensuous design.

The building envelope + skin

Just as the human skin performs important functions in response to climate conditions, so does the building skin. Humans have responded to climate conditions for millenium; physical skin and artificial skins (i.e. clothing) protect and respond to the elements based on physiological and psychological comfort. Skin functions to release or retain heat. Clothing functions as a second skin, adding extra protection and allowing for the manual manipulation of individual comfort. Ultimately, skins function as barriers, facilitators, and response mechanisms. As a thermal barrier, the building envelope has the potential to regulate interior temperatures, thus determining the amount of energy required to maintain thermal comfort. The building skin is essentially the first line of defense against the elements; if poorly designed and inadequate, the building must work harder through other means to allow for comfort of the users. According to the U.S. Department of Energy, space heating, cooling, and air conditioning (HVAC) account for the largest amount of end-use energy consumption in both residential and commercial buildings. If designed appropriately and thoughtfully, the building envelope can regulate and even produce energy.

The skin is also beautiful. It is a soft outer covering that wraps a complex interior of structural and functional mechanisms providing protection, facilitation, and flexibility. Skin is our largest organ and is made up of multiple unique layers. Architects like Santiago Calatrava have drawn inspiration from natural and human forms, fusing them with carefully chosen materials to create aesthetic harmony. Calatrava’s ‘skin’ buildings are unique, symbolic, and beautiful. His latest work, the sleek and sustainable “Museum of Tomorrow” is part of a massive urban revitalization project planned for the 2016 Olympics Games in Rio de Janeiro, Brazil. His design features a transforming façade that adapts to the changing climate conditions (Figure 3).

The building envelope + energy consumption

Energy consumption depends predominantly on the performance of the building envelope. Approximately 50% of energy consumption [CO₂]...
emissions are related to buildings. Because artificial heating, cooling, and lighting are the largest consumers of a building’s energy, minimizing transfer through the building envelope is crucial. In both hot and cold climates, the building envelope can reduce the total amount of energy required. In some cases, mechanical and electrical systems can be rendered unnecessary if the building envelope functions productively and appropriately. This does not mean, however, that a building must adopt the appearance of a power plant; on the contrary, the ecological design elements of a building should be beautiful and elegant in order to increase the overall comfort of the participants and viewers. Thus will both the ecological and sensual aspects of the building as a whole be strengthened. One cannot exist without the other.

Functions of the building envelope

The building envelope has the potential for multiple functions, including, but not limited to: enhancement and maximization of daylight, solar radiation protection/rejection of heat, ventilation, heat collection, electricity generation, and exploitation of pressure differentials. Many functions directly influence energy consumption, but others, such as daylight and glare, are more directly related to the comfort of the user. Visual comfort is beauty. Buildings must combine ecological design with aesthetics in order to be desired by their users.

Daylight
- The enhancement of daylight, e.g. light shelves/reflectors
- The maximization of daylight, e.g. full-height glazing/atria (Fig. 06)

Solar Radiation Protection + The Rejection of Heat
- The rejection of heat, e.g. overhangs/brise soleil
- e.g. louvres/blinds (Fig. 07)

Ventilation
- e.g. natural ventilation

Electricity Generation
- e.g. photovoltaics (Fig. 08)

Heat Collection
- e.g. solar collectors (Fig. 09)

Pressure Differentials
- e.g. ventilation chimneys

The impact of building envelope design on energy efficiency and aesthetics

Maximizing efficiency through design

The design and construction of the building envelope is the single greatest potential controller of the interior environment. The overall design of the building envelope can determine the amount of lighting, heating, and cooling a building will require. Thus, good design has the potential to maximize efficiency. Passive solar heating, for example, uses the sun’s heat to warm the building when it is cold without relying on any mechanical or electrical equipment.

Local Climate

Local climate conditions must be taken into extensive consideration. Climate is an essential determinant for identifying the design features that will result in the greatest reductions of energy needs. Climate research, such as solar position, solar...
radiation, rainfall, humidity, wind, and temperature must influence design decisions in order to make the building environmentally viable. Responding to climate conditions produces a vast array of functional and beautiful design opportunities.

**Typologies and aesthetics**

A plethora of façade typologies may be utilized for the building design, each concept lending itself to diverse visual communication. A perforated façade, for example, may be considered less beautiful than a double-skin façade, simply because one is more symmetrical than the other. This leads to the question of criteria. Psychological studies have shown that symmetry, perspective, and lighting are among universal factors contributing to the perception of beauty.

**What is beauty?**

Is beauty simply in the eye of the beholder? When we say something is beautiful, are we inadvertently telling others that they should take delight in it? Alexander Nehamas, a professor in the departments of philosophy and comparative literature at Princeton University probes the topic. Beauty may be intersubjective, he says, but is it objective? Can we argue rationally about whether something is beautiful? Nehamas thinks that it illuminates our style. Is taste a function of education and economics? Is beauty an intrinsic aspect of sustainability? Is natural beauty better than constructed beauty? What is the relationship between beauty and the sublime? Nehamas says that the sublime is our reaction in the face of something so overpowering that it consumes or obliterates us. Ultimately, why does beauty matter? Beauty, like travel, matters because we are able to better proportion ourselves within the world. What we find beautiful is a reflection of our personality and individuality. We learn about ourselves by what we find beautiful. Beauty is how we identify and categorize the world around us, and those within the world. It is how we perceive the built environment and what drives our choices in life. Beauty matters because, like innate human desire, it is something we subconsciously strive for always. Does it not make sense that sustainability as it relates to climate design, be beautiful? Sustainability is a multifaceted concept that takes into consideration social, economical, and ecological factors. Sustainability must also take into consideration beauty and aesthetics, for it is as an important driving force as the social, economical, and ecological.

**Case Studies**

**Kunsthaus by Peter Zumthor | Bregenz, Austria**

Architects possess the rare and coveted opportunity of executing an idea in three dimensional form. The sensuousness of the architecture is born from the material embodiment of the idea in terms of the senses through which it will be perceived. The Kunsthaus in Bregenz, Austria, is a strong architectural example of this phenomenon. One does not have to be familiar with the project to be able to admire the precise and elegant use of material. Daylight reigns supreme, integrated seamlessly within each floor division, each staircase, and every doorway. Rooms cease to be rooms, the mind submits to experience, sifting in and out of...
out of diffused and sultry concrete mist (Fig. 13). Completely covered in translucent feathered panels with only minor perforations for access, the exterior skin of the Kunsthaus glistens in uniform texture, intermittently revealing its underlying structural integrity (Fig. 12). Is this not sustainability? How can we not make the experiential viewer aware of any ecological decisions without first capturing the human heart-strings and making them awed and intrinsically curious about the design at hand?

**Oskar von Miller Forum by Herzog + Partner | Munich, Germany**

The Oskar von Miller Forum, located in the heart of Munich, The Oskar von Miller Forum is an independent educational initiative supported by the Bavarian construction worker's union that is dedicated to enhancing the image of the construction engineering industry worldwide. Many, if not all aspects of the building envelope were designed to reduce energy consumption through passive and active means. Ventilation, acoustical dampening, louvers, sliding systems, perforated panels, photovoltaics, and thermal collectors all contribute to a holistic design that expresses itself on ecological terms. However, anyone that steps foot into the Oskar von Miller Forum will instantly be captivated by the incredible level of detail and craftsmanship that so characterizes the building. Pre-fabricated ultra-smooth concrete columns dot communal areas, creating sensual perspective. Diffused daylight slips into the space though an infinite sea of translucent and transparent louvers. Sliding wooden panels create visual symmetry yet function to reject solar radiation when necessary. The Oskar von Miller Forum, designed by Herzog + Partner, uses building construction and design as a direct means of creating comfort. Munich is a relatively cold climate, and therefore building design is inclined to consider heating rather than cooling. However, during the summertime cooling is predominantly produced by utilizing solar energy gained from the building's photovoltaic and vacuum tube systems. Roland Schneider, Herzog + Partner project manager for the Oskar von Miller Forum initiative, summarized the double-skin building façade as a primary buffer zone against sound and noise coming off the street as well as protection against cold in the wintertime. The shading structure, or façade panels, are the first zone that shelters the indoor climate from the outdoor climate whether from wind, noise, heat or cold. Everything is related to climate design, even the thermal effect of warm air rising. The vertical panels that cover the façade alternate from translucent to transparent. The translucent part does not allow as much radiation to come through as the transparent part thus the transparent part points towards the southeast. In the morning hours this helps heat up the space while the afternoon sun, especially in the summertime, is mostly kept out.

Another important aspect of the building envelope is the thermal stack effect as a driving force for the natural ventilation, pulling fresh air from the north side through the staircase into the communal zone before leaving the building through the façade. The dimensions of all the ventilation openings, including the holes of the perforated panels in between the staircase and the communal space, the dimensions
of the doors and the opening of the façade were designed in such a way to optimize airflow. If one barrier was smaller than another one the whole airflow would not work. “It’s like a chain,” says Schneider, “a chain is as strong as its weakest link.” The whole airflow system was simulated using special simulation tools. The dimensions of the façade were designed by calculating the effects of various depths of the façade with regard to the ventilation. The result is stunning.

Both the Kunsthaus and the Oskar von Miller Forum are exquisitely beautiful buildings. Yet their beauty is more than surface deep. The Kunsthaus dominates the diffusion of daylight from exterior to interior space, transporting visitors on an ethereal journey from floor to floor. The Oskar von Miller Forum is a tremendous example of the design potential for an energy efficient building. Because of their beauty, both buildings intrigue, activate, and engage the viewer. This is necessary in order to educate and propagate climate design and energy concepts as a holistic approach.

Conclusion

Ultimately, the design potential of the building envelope is enormous. As stewards for an industry that garners so much control over the reduction of carbon emission, architects must take into serious consideration building energy consumption, and thus the design of the building envelope. However, as everything is interrelated, the function of the building envelope cannot be taken in isolation. The visual and aesthetic impact must be also be integrated with all other design elements in order to create a cohesive building that responds to the local climate, delivers a comfortable standard to the inhabitants, and reduces environmental impact.

Notes


Figures

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Fig. 03 http://www.inhabitat.com/2010/06/22/santiago-calatrava-unveils-green-museum-of-tomorrow-in-rio/
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Interview. Roland Schneider, Project Manager Herzog + Partner. June 30, 2010. 8:12pm.